

REMARKS

Applicants request favorable reconsideration and allowance of the subject application in view of the preceding amendments and the following remarks.

Claims 1-24 and 49-52 having been previously cancelled, Claims 25 through 48 are now presented for examination. Claims 25 and 37 have been amended to define still more clearly what Applicants regard as their invention, in terms which distinguish over the art of record. Claims 25 and 37 are the only independent claims.

Claims 25-29, 31-33, 36-41, 43-45 and 48 have been rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent 4,475,223 (Taniguchi et al.) in view of previously cited U.S. Patent 5,530,518 (Ushida et al.) and further in view of previously cited U.S. Patent 6,020,950 (Shiraishi et al.). Claims 30, 34, 35, 42, 46 and 47 have been rejected under 35 U.S.C. § 103(a) as unpatentable over Taniguchi et al. in view of Ushida et al., further in view of Shiraishi and further in view of U.S. Patent 5,894,341 (Nishi et al.).

Independent Claim 25 as currently amended is directed to exposure apparatus that performs exposure using EUV or X-rays in a vacuum. In the apparatus, a projection optical system projects a pattern formed on a first object onto a second object by using the EUV or X-rays passing through the vacuum. The projection optical system has a diaphragm in the vacuum irradiated by the EUV or X-rays from the first object scattered by the pattern and a cooling device which removes heat absorbed from the scattered EUV or X-rays by the diaphragm during projection of the pattern. The diaphragm is not irradiated by the EUV or X-rays from the first object that are not scattered by the pattern.

Independent Claim 37 as currently amended is directed to a device manufacturing method in which exposure of a pattern formed on a reticle onto a wafer is performed in a vacuum

by projecting EUV or X-rays through the vacuum. A diaphragm of a projection optical system in the vacuum is irradiated by the EUV or X-rays from the reticle scattered by the pattern. Heat absorbed by the diaphragm from the scattered EUV or X-rays is removed during the exposure of the pattern. The device is manufactured from the wafer. The diaphragm is not irradiated by the EUV or X-rays from the reticle that are not scattered by the pattern.

In Applicants' view, Taniguchi et al. discloses an X ray exposure process and system for transferring a mask pattern onto a wafer using X rays in which heights on the mask at many points are measured on a light interference band basis by a mask-height measuring device of non-contact measurement type at an X ray exposure position. The mask is mounted on a chamber which is filled with an He gas and or the like to prevent attenuation of an X ray source. Heights on the wafer at many points are measured at a wafer-height measuring position different from said exposure position, and according to the measured results, the wafer is finely moved upwardly or downwardly (that is, deformed) individually independently by means of a chuck which sucks and holds the wafer at many points thereon so that, a gap between the mask and wafer is adjusted to a desired level.

In Applicants' opinion, Ushida et al. discloses a projection exposure apparatus that includes an illuminating optical device for illuminating a projection negative and a projection optical device that projection-exposes a projection negative illuminated by the illumination optical device onto a substrate and Shiraishi et al. '950 discloses an exposure method and projection exposure apparatus in which a light shielding plate for limiting light near an optical axis has a set of fixed peripheral openings with a fluid path through the center of the plate.

According to the invention defined in Claims 25 and 37 as currently amended, a projection optical system that projects a pattern formed on a first object onto a second object

using EUV or X-rays passing through a vacuum has a diaphragm in the vacuum. The diaphragm is irradiated by the EUV or X-rays scattered by the pattern and heat absorbed from the scattered EUV or X-rays by the diaphragm during pattern projection is removed. EUV or X-rays not scattered from the first object do not irradiate the diaphragm. Advantageously, the adverse effects of the heating of a projection optical system diaphragm in a vacuum by scattered EUV or X-rays are avoided.

Taniguchi et al. may disclose a projection optical system using X-rays generated in a vacuum. As clearly shown in Fig. 4 of Taniguchi et al., the X-rays from the vacuum chamber 2 pass through a helium atmosphere chamber 50 to reach a mask 10 and then pass through an uncontrolled atmosphere to reach a wafer 16. There is, however, no diaphragm in a vacuum between the mask 10 and the wafer 16 nor is the alignment scope 15 of helium atmosphere chamber 50 in the X-ray path during exposure affected by X-ray irradiation. As a result, it is not seen that Taniguchi et al. in any manner teaches or suggests anything relating to a projection optical system diaphragm in a vacuum between a first object (e.g., reticle) and a second object (e.g., a wafer) that is irradiated by EUV or X-rays scattered by a pattern. Accordingly, Taniguchi et al. which does not have a projection optical system with a diaphragm in a vacuum fails in any manner to suggest a projection optical system that projects a pattern formed on a first object onto a second object by using EUV or X-rays passing through a vacuum as in Claims 25 and 37.

Ushida et al. may teach the use of a variable aperture stop 10a in a projection optical system but fails in any manner to consider scattering of EUV or X-ray radiation by a pattern or any heating effect of such radiation scattering on the aperture stop 10a. The Ushida et al. disclosure is devoid of any suggestion of (1) an aperture stop of a projection optical

system in a vacuum, (2) irradiation of an aperture stop by EUV or X-rays scattered by a pattern on a first object (e.g., reticle), (3) no irradiation of the aperture stop by EUV or X-rays that are not scattered by the pattern or (4) removal from the diaphragm of heat from EUV or X-rays scattered by the pattern as in Claims 25 and 37.

Shiraishi discloses a cooling arrangement for a light shield that is not in a vacuum and only limits a beam of light passing through a Fourier transform plane which propagates near the optical axis of a projection optical system. As clearly disclosed at least at lines 49 through 57 of column 13 of Shiraishi with respect to Figs. 4 and 5, "The light-shielding plate FL has a central light-shielding portion FLc consisting of a metal material and formed on the upper surface (reticle side) of a transparent nitride material such as quartz, and an annular light-shielding portion FLr formed around the pupil plane EP. As shown in FIG. 5, the central light-shielding portion FLc has a circular shape, and the annular light-shielding portion FLr is larger than the effective pupil radius so as not to eclipse a beam of high-frequency light components.". As a result, the central light shielding portion FLc is irradiated by all light that passes near the optical axis whether or not the light is scattered by a reticle pattern and the annular shielding portion is not irradiated by the light. Accordingly, it is not seen that Shiraishi's limiting of light near the optical axis by a light shielding portion FLc that is cooled in any manner teaches or suggests a diaphragm in a vacuum irradiated by EUV or X rays from a first object (e.g., reticle) that is scattered by a pattern formed on the first object and is not irradiated by the EUV or X-rays from the first object not scattered by the pattern as in Claims 25 and 37. Further, it is not seen that Shiraishi's cooling of the central shielding portion FLc could suggest the feature of a diaphragm that removes heat absorbed from the scattered EUV or X-rays during projection of the pattern.

With regard to the cited combination, Taniguchi et al. only teaches X-rays from the vacuum chamber 2 that pass through a helium atmosphere chamber 50 to reach a mask 10 and then pass through an uncontrolled atmosphere to reach a wafer 16 but fails to suggest a projection optical system that projects a pattern formed on a first object (e.g., reticle) onto a second object (e.g., wafer) using EUV or X-rays passing through a vacuum in which there is a diaphragm. Ushida et al. is restricted to teaching the use of a variable aperture stop 10a in a projection optical system without any consideration of scattering of EUV or X-ray radiation by a pattern or heat removal of EUV or X-ray radiation scattering on the aperture stop 10a during projection. Shiraishi is limited to teaching a central light shield that only limits light near the optical axis of a light beam. Such a central light shield is directed away from a diaphragm in a vacuum that removes heat absorbed from EUV or X-rays scattered by a reticle pattern but is not irradiated by EUV or X-rays not scattered by the pattern.

Accordingly, it is not seen that the addition of Shiraishi's central light shield not in a vacuum that limits light only near the optical axis to Ushida et al.'s variable aperture stop for light without any consideration of scattering of EUV or X-rays by a reticle pattern and the addition of these references to Taniguchi et al.'s X-rays that pass through a helium atmosphere before reaching a mask and then through an unspecified atmosphere to reach a wafer rather than passing through a projection optical system in a vacuum from a reticle to a wafer could possibly suggest a projection optical system diaphragm in a vacuum that removes heat absorbed from EUV or X-rays scattered by a reticle pattern during exposure and is not irradiated by EUV or X-rays from the reticle not scattered by the pattern as in Claims 25 and 37. It is therefore believed that Claims 25 and 37 as currently amended are completely distinguished from any

combination of Taniguchi et al., Ushida et al. and Shiraishi and are allowable.

For the foregoing reasons, Applicant submits that the present invention, as recited in independent claims 25 and 37, also is patentably defined over the cited art.

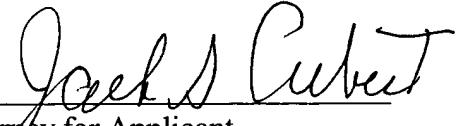
Dependent claims 26-36 and 38-48 also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in independent claim 21. Further individual consideration of this dependent claim is requested.

Applicant further submits that this Amendment After Final Rejection clearly places this application in condition for allowance. This Amendment was not earlier presented because Applicant believed that the prior Amendment placed the application in condition for allowance. Accordingly, entry of the instant Amendment, as an earnest attempt to advance prosecution and reduce the number of issues, is requested under 37 CFR 1.116.

Favorable reconsideration, withdrawal of the rejection set forth in the above-noted Office Action and an early Notice of Allowance are also requested.

Applicant's attorney, Steven E. Warner, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should be directed to our address listed below.

Respectfully submitted,



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